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AUTHOR Kearsley, Greg P.
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ABSTRACT

This report presents information about the state of the art in Computer Assisted Instruction (CAI) in 1976. This information takes the form of quantitative data (mostly frequency distributions), on the number and average completion time of CAI programs according to subject matter, author, language, instructional strategies, sources, and central processor. These data provide an overview of current activity in CAI and may be of general interest to those involved in the field, or useful for the purpose of educational planning and decision-making. The sole source for this information was the 1976 edition of the "Index to Computer Based Learning," edited by A. Wang and published by the Instructional Media Laboratory of the University of Wisconsin-Milwaukee. (Author/VT)

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RIR-76-4

SOME "FACTS" ABOUT CAI: 1976 IN DEPTH

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Greg P. Kearsley

Division of Educational Research Services

University of Alberta

IR005769

ABSTRACT

Descriptive data on various aspects of CAI in 1976 are reported including subject matter, author languages, instructional strategies, sources, and central processors. The sole data source was the 1976 edition of the Index to Computer Based Learning.

This report presents some "facts" about the state of the art in Computer Assisted Instruction (CAI), circa 1976. These "facts" take the form of quantitative data (mostly frequency distributions) on the number and average completion times of CAI programs according to subject matter, author language, instructional strategies, sources, and central processor. These data provide an overview of current activity in CAI and may be of general interest to those involved in the field or useful for the purposes of educational planning and decision-making.

The sole source for these data was the 1976 edition of the Index to Computer Based Learning , edited by A. Wang and published by the Instructional Media Laboratory of the University of Wisconsin-Milwaukee. The Index is designed as a resource catalogue for CAI programs and provides 23 items of information (where available) for each program listed. This information was acquired via a questionnaire distributed to CAI centers throughout the world. While the Index is primarily designed as a guide to available CAI courseware, it also provides the most comprehensive and up-to-date documentation on CAI which is publicly available. Because of this characteristic, it can be considered to be a representative sample of existing CAI courseware. Hence, it is felt that the data presented herein are as good as can be reasonably obtained at the present time.

However, it is emphasized that the Index provides only one sample with certain inherent biases and error. Because the data was acquired on a voluntary basis and not corroborated, there are bound to be some inaccuracies. In addition, the

questionnaire provided no guidance regarding the exact nature of the various categories, leaving this instead to the interpretation of the respondent. Since different respondents are likely to categorize things somewhat differently (e.g., type of instruction, total available course hours, etc.), error is introduced. For these reasons (and others which will be mentioned at the appropriate places), the following data must be taken as approximate in all cases. [1]

GENERAL DETAILS.

Some general summary statistics are given in Table 1.

Insert Table 1 here

There were 1837 separate programs available covering 137 different subject matters. These programs originated from 219 different sources and used one or more of 17 types of instructional strategies. The programs could have been written in one of 76 author languages in use running on one of 116 different types of central processors.

No estimates are available for either the total number of hours of instruction available or the average student completion times. This is because the number of average instructional hours was reported for only 44% of the programs listed, and average

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1. These remarks are not intended to demean the value of the Index as a resource catalogue (for it is excellent) but rather to point out its limitations as a data source for this particular study.

student completion times were reported for 57% of the programs. Furthermore, of those programs providing these data, the times were often in time units such as days, semesters, weeks, or number of problems rather than hours. A rough estimate of total available instruction hours for the 44% of the programs giving this information is in the order of 10,000 hours.

It is possible to use the available time data, however, to get some idea of the distribution of instructional hours and course lengths. Table 2 indicates the number of programs falling in the indicated ranges of total available instructional hours.

Insert Table 2 here

As the Table shows, the vast majority of programs are in the 1-5 range of available hours. The number of programs in the 10-50 hour range is relatively small but not negligible. There are few programs in the 50-100 hour range. There were 16 programs listed with over 100 hours of available instruction, the longest belonging to the U.S. Army with 695 hours.

The distribution for number of programs according to average student completion times (in hours) is given in Table 3.

Insert Table 3 here

The majority of average program lengths fall in the 1-5 hour and the less than 1 hour ranges. There are about 100 programs with times in the 10-50 hour range, 19 in the 50-100 hour range, and

6 over 100 hours.

SPECIFIC DETAILS.

This section presents specific details on the frequency of programs according to subject matter, author language, central processor, instructional strategy, and source. Two measures of frequency were used; total number of programs, and total average student completion time. Both of these measures have their respective virtues and weaknesses. Total number of programs provides an indication of the scope of a particular variable or dimension (i.e., some subject matter, author language, etc.). On the other hand, total student completion times reflect the density of activity with respect to these variables. Both measures can be somewhat misleading as in the cases of a large number of very short programs or a small number of very large programs. Since neither measure is ideal, the following data is reported in terms of both frequency measures. However, the total completion times are based only on the 57% of programs which provided this statistic while the total number of programs is based on the full sample.[2]

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2. In addition, 3 long Army electronics programs (471, 619, 695 hrs. each) were excluded from all analyses except the total hours by sources. It was felt the inclusion of these three programs would distort the presentation. Also excluded were about 50 programs from Coast Community College which had unreasonable total completion times (these are being investigated).

Subject Matter

The 10 most frequent subject matters are shown in Figure 1a according to total number of programs and Figure 1b according to total average completion hours.

Insert Figures 1a & 1b here

In terms of the total number of programs, mathematics (including arithmetic, calculus, statistics, trigonometry, and algebra) is the most frequent subject matter presented by CAI, followed closely by the health professions (12 separate subjects). The biological sciences include programs in genetics, botany, and zoology. Foreign languages encompass 14 different languages. Business includes accounting but not economics (which had 28 programs). The 10 subject areas indicated in Figure 1a account for 1324 programs or 72% of the programs listed. The remaining 28% includes a diversity of subjects such as agronomy, cinema studies, driver education, ecology, graphic arts, journalism, logic, nuclear warfare, psycholinguistics, and urban planning.

Looking at subject matter according to total average completion times (figure 1b), it can be seen that by this measure, foreign language is the most frequent subject matter, followed by the health professions and then mathematics. Biological sciences and psychology which were in the 10 most

frequent by total number of programs, are not in the 10 most frequent by total hours. Although there are relatively few electronics and engineering programs, they tend to be long and hence are included in the 10 most frequent by total completion times. This is also true of foreign language programs which ranked 7th most frequent by number of programs but 1st according to total average completion times.

Author Languages

The 10 most frequent author languages are shown in Figure 2a by total number of programs and in Figure 2b for total average completion times.

Insert Figures 2a & 2b here

Considering first Figure 2a, APL involves the largest number of programs, followed by TUTOR, COURSEWRITER, and BASIC. However, looking at Figure 2b the most frequent language in terms of average completion times is by far TUTOR, followed by COURSEWRITER, then BASIC and APL. The reasons for these differences stem from the nature of the sources which use these languages. Of the total 578 APL programs, 519 programs originate from Coast Community College. Most of these programs tend to be quite short (i.e. less than 1 hour). On the other hand, 253 of the 342 programs written in TUTOR come from the University of Illinois, whose programs tend to be fairly long (10-50 hours). This is why APL appears first by number of programs but fourth according to total time. In addition there are a number of short

programs in COBOL which shows up in the 10 most frequent languages by number but not by time, and a few long programs in CAN (the author language used at Ontario Institute for Studies in Education) and FOCAL which do not show up in the 10 most frequent by number of programs. CATALYST/PIL is an author language used at the University of Pittsburg running on a DEC 1000 system. The 10 languages shown in Figure 2a account for 1461 programs or about 80% of the total programs. This means that the remaining 20% of the programs are spread out over the other 66 languages. (Actually there are fewer distinct languages since this figure counts different versions of the same language separately.)

In terms of the number of sources using the same author language (or a version thereof), BASIC is the most widely used language (being used at 14 sources), followed by COURSEWRITER (9 sources) and TUTOR (5 sources).

Central Processors

The 10 most frequent Central Processing Units (CPU's) in use are indicated in Figures 3a and 3b according to number of programs and total average completion hours respectively.

Insert Figures 3a & 3b here

By total number of programs, IBM 360/370 CPU's are most frequent followed by CDC Cybers. But in terms of total hours, CDC Cyber is most frequent followed by IBM 360/370's. This is again due to

the influence of the long PLATO programs from the University of Illinois (which runs on CDC Cybers). In terms of different installations, the IBM 360/370 is the most widely used CPU for CAI purposes. It is interesting to note that PDP's which are essentially small or mini-computers rank fifth by number of programs.

Instructional Strategies

The total number of programs and average program lengths for the 10 most frequent instructional strategies are shown in Figures 4a and 4b.

Insert Figures 4a & 4b here

It should be realized that while the other categories have been exclusive, the instructional strategies are not--a program may involve more than one type of strategy. Either by total number of programs or total average completion times, a drill & practice strategy is most frequent, followed by a tutorial strategy. Problem solving strategies rank third by number but fifth by time possibly suggesting that problem solving strategies tend to be used in shorter programs.

Sources

Figures 5a and 5b show the 10 most frequent sources by total number of programs and total completion times respectively.

Insert Figures 5a & 5b here

Coast Community College accounts for the largest number of programs, followed by the University of Illinois. However, in terms of total completion times, the University of Illinois ranks first and Coast community college ranks fourth after the U.S. Armed Forces and the University of Minnesota. As has been mentioned, this reflects the tendency of the Illinois programs to be long and the Coast Community college programs to be short. The rather large number of total completion hours for the U.S. Armed Forces is due to 3 very large electronics programs totaling 1785 hours. This is also true of the University of Alberta, Computer Curriculum Corporation, and OISE (Ontario Institute for Studies in Education) which have a few long programs which comprise their total hours. The fact that there are quite a few institutions in the "top ten" by total number of programs but not total hours and vice-versa possibly reflects differences in CAI orientation (e.g. research versus teaching).

It is interesting to note that Forschungszentrum fur Rehabilitation und Pravention (F.R.P.), Heidelberg and the University of Leeds appear in the 10 most frequent sources by number of programs. While most of the 219 sources are in the U.S., the following countries are also represented: Australia, Belgium, Canada, England, France, Germany, Holland, Italy, Israel, Scotland, and Spain. The U.S.S.R. is not represented although they are definitely engaged in CAI activity.

SUMMARY

The preceding data can be summarized in the following conclusions:

1. In terms of subject matter, the largest proportion of CAI programs are devoted to mathematics, foreign languages, and health professions. In general, subject matters involving problem solving or deductive types of curricula are well represented while subject matter involving the arts or humanities (e.g. philosophy, anthropology, sociology, etc.) are minimally represented.
2. As far as author languages are concerned, TUTOR, APL, COURSEWRITER, BASIC and FORTRAN are the mostly frequently used languages. BASIC is the most widely used language. Many programs are written in languages local to their source.
3. The general purpose IBM 360/370 CPU's are the most widespread central processor used for CAI courses. Mini-computers are not widely used for CAI purposes at present.
4. Most programs involve a mixture of different instructional strategies, however, drill & practice is the most frequent single strategy. Socratic and inquiry strategies are not widely used.
5. There are a few major centers which have a large number of programs while most centers have a small number (i.e., 1-5). The PLATO system of the University of Illinois dominates the CAI community in terms of developed courseware.
6. Most CAI courseware offers between 1-5 hours and instruction and has an average completion time around 1 hour or less. The availability and quality of the data on hours of instruction

(either available or average completion times) is poor.

7. The two measures of frequency, total number of programs and total student completion time reveal different relative ranks for many categories. This suggests that some care is demanded in generalizing about the relative importance of a particular source, language, CPU, etc., since any such claim will be measure-dependent for its validity.

ACKNOWLEDGEMENT

I would like to thank S. Hunka and G. Romaniuk for reading and commenting on an earlier draft of this report.

TABLE 1.

Summary Statistics for 1976.

Total Subjects Available	137
Total Number Sources	219
Total Programming Languages	76
Total Number of Instructional Strategies	17
Total Number of CPU Types	116
Total Programs Available	1837

TABLE 2.

Instructional Hours Available.

HOURS	NUMBER OF PROGRAMS
<1	54
1-5	497
6-10	78
11-15	32
16-20	31
21-25	18
26-30	18
31-35	10
36-40	6
41-45	4
46-50	6
51-60	15
61-70	8
71-80	3
81-90	2
91-100	3
>100	16

TABLE 3.

Average Student Completion Hours.

HOURS	NUMBER OF PROGRAMS
<1	396
1-5	450
6-10	75
11-15	23
16-20	23
21-25	11
26-30	13
31-35	7
36-40	4
41-45	8
46-50	8
51-60	4
61-70	7
71-80	4
81-90	3
91-100	1
>100	6

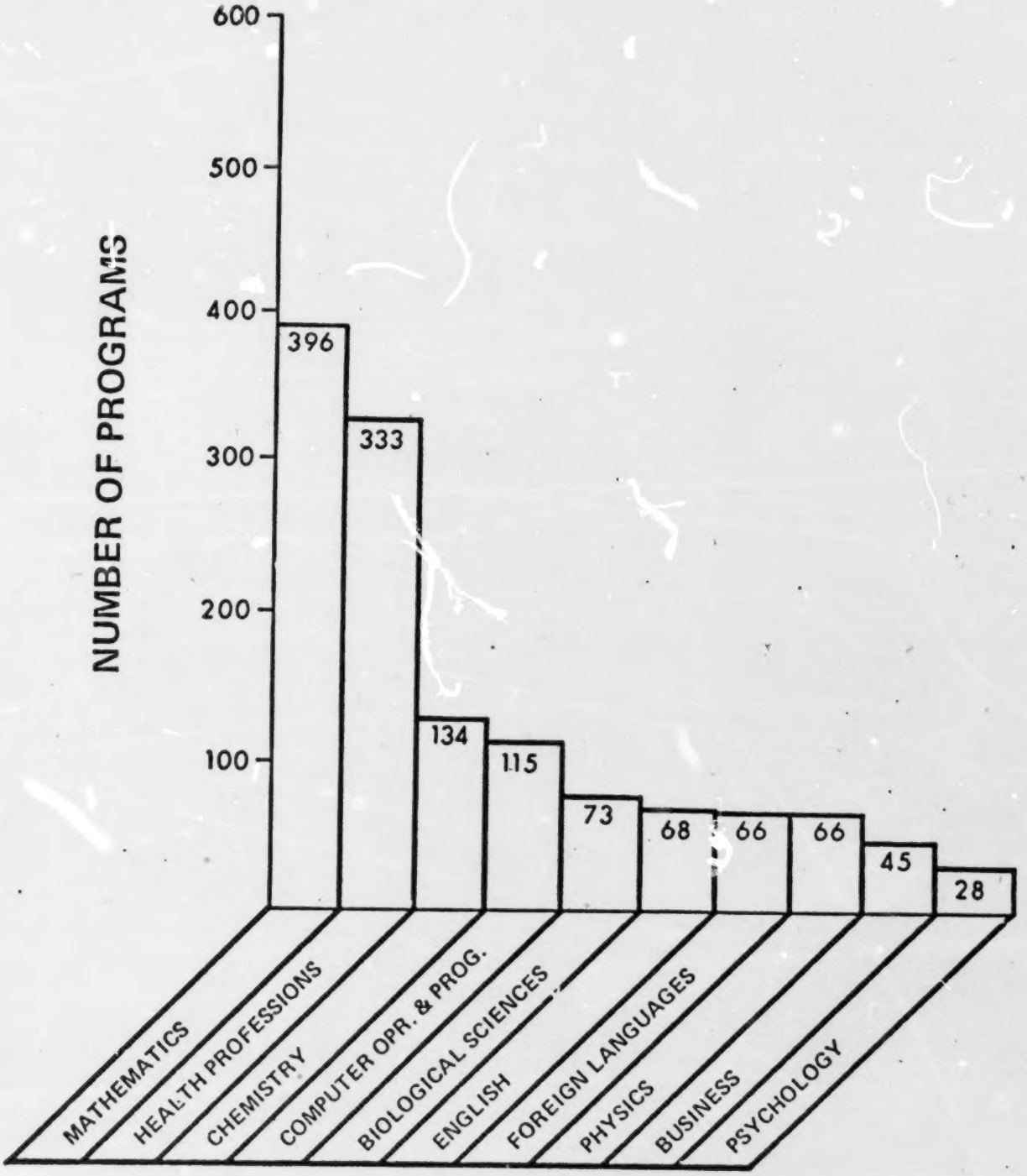
NUMBER OF PROGRAMS
600
500
400
300
200
100
396
333
134
115
73
68
66
66
45
28
MATHEMATICS
HEALTH PROFESSIONS
CHEMISTRY
COMPUTER OPR. & PROG.
BIOLOGICAL SCIENCES
ENGLISH
FOREIGN LANGUAGES
PHYSICS
BUSINESS
PSYCHOLOGY

FIGURE 1A

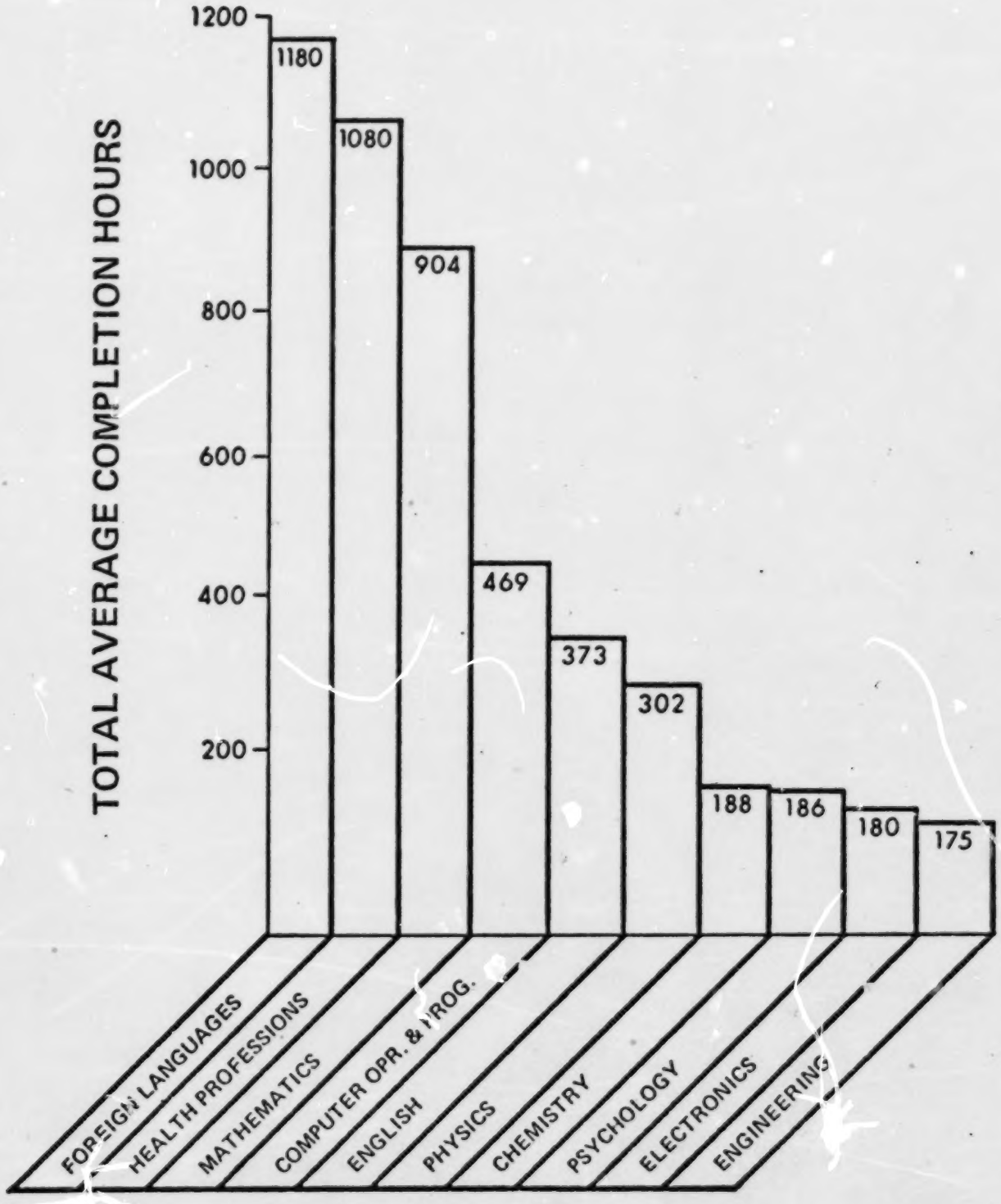
TOTAL AVERAGE COMPLETION HOURS
1200
1000
800
600
400
200
1180
1080
904
469
373
302
188
186
180
175
FOREIGN LANGUAGES
HEALTH PROFESSIONS
MATHEMATICS
COMPUTER OPR. & PROG.
ENGLISH
PHYSICS
CHEMISTRY
PSYCHOLOGY
ELECTRONICS
ENGINEERING

FIGURE 1B

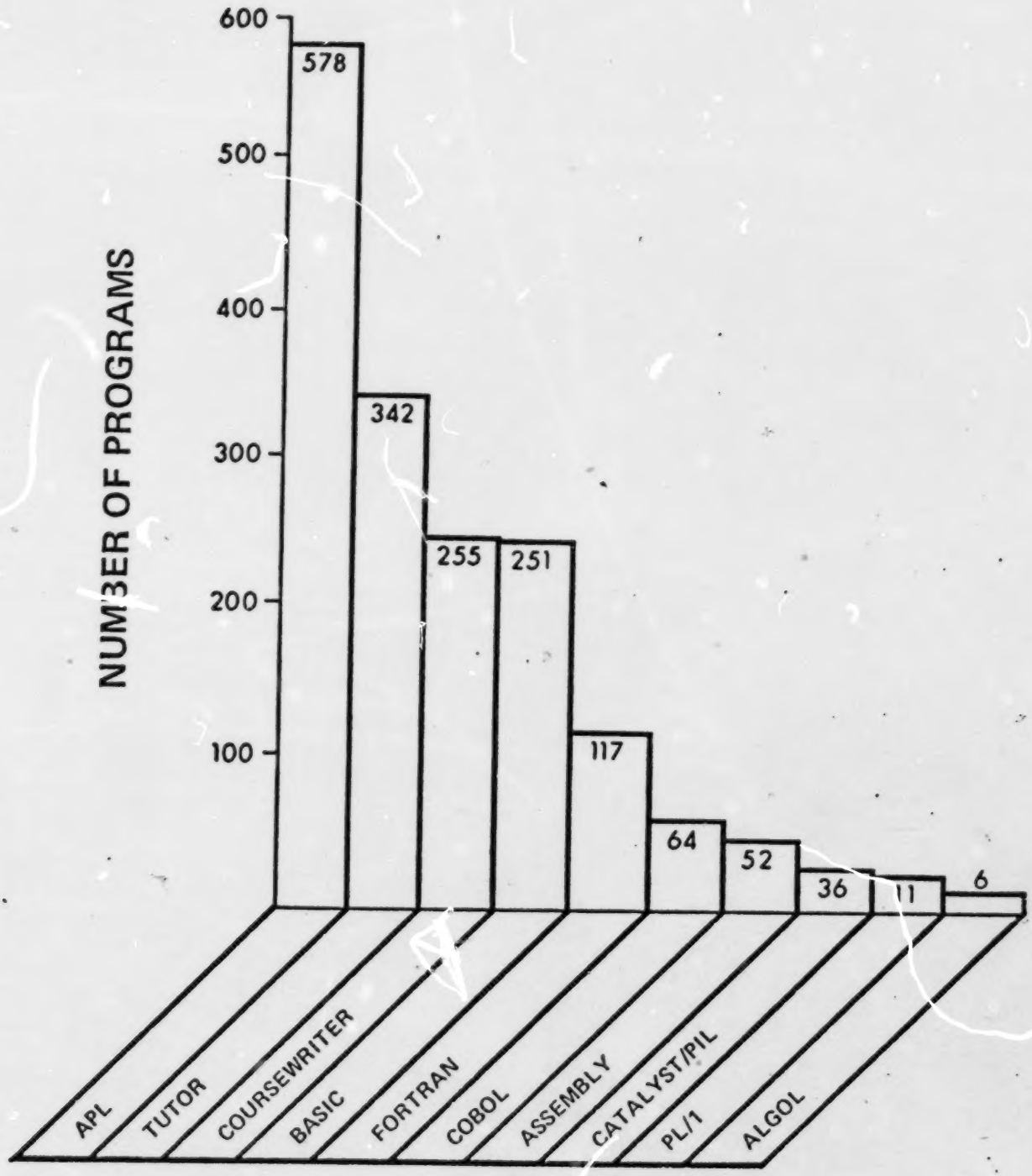
NUMBER OF PROGRAMS
600
500
400
300
200
100
578
342
255
251
117
64
52
36
11
6
APL
TUTOR
COURSEWRITER
BASIC
FORTRAN
COBOL
ASSEMBLY
CATALYST/PIL
PL/1
ALGOL

FIGURE 2A

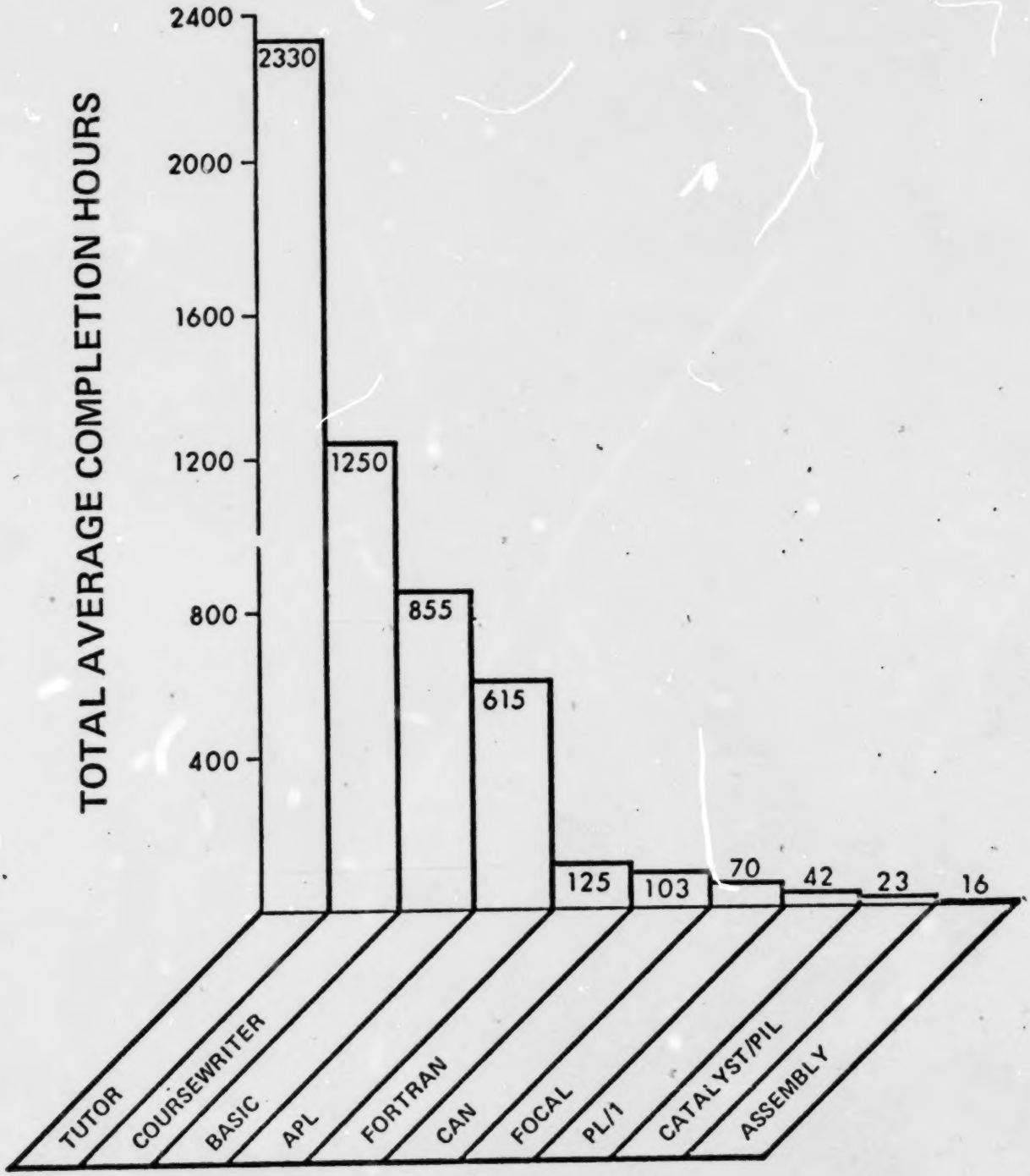
TOTAL AVERAGE COMPLETION HOURS
2400
2000
1600
1200
800
400
2330
1250
855
615
125
103
70
42
23
16
TUTOR
COURSEWRITER
BASIC
APL
FORTRAN
CAN
FOCAL
PL/1
CATALYST/PIL
ASSEMBLY

FIGURE 2B

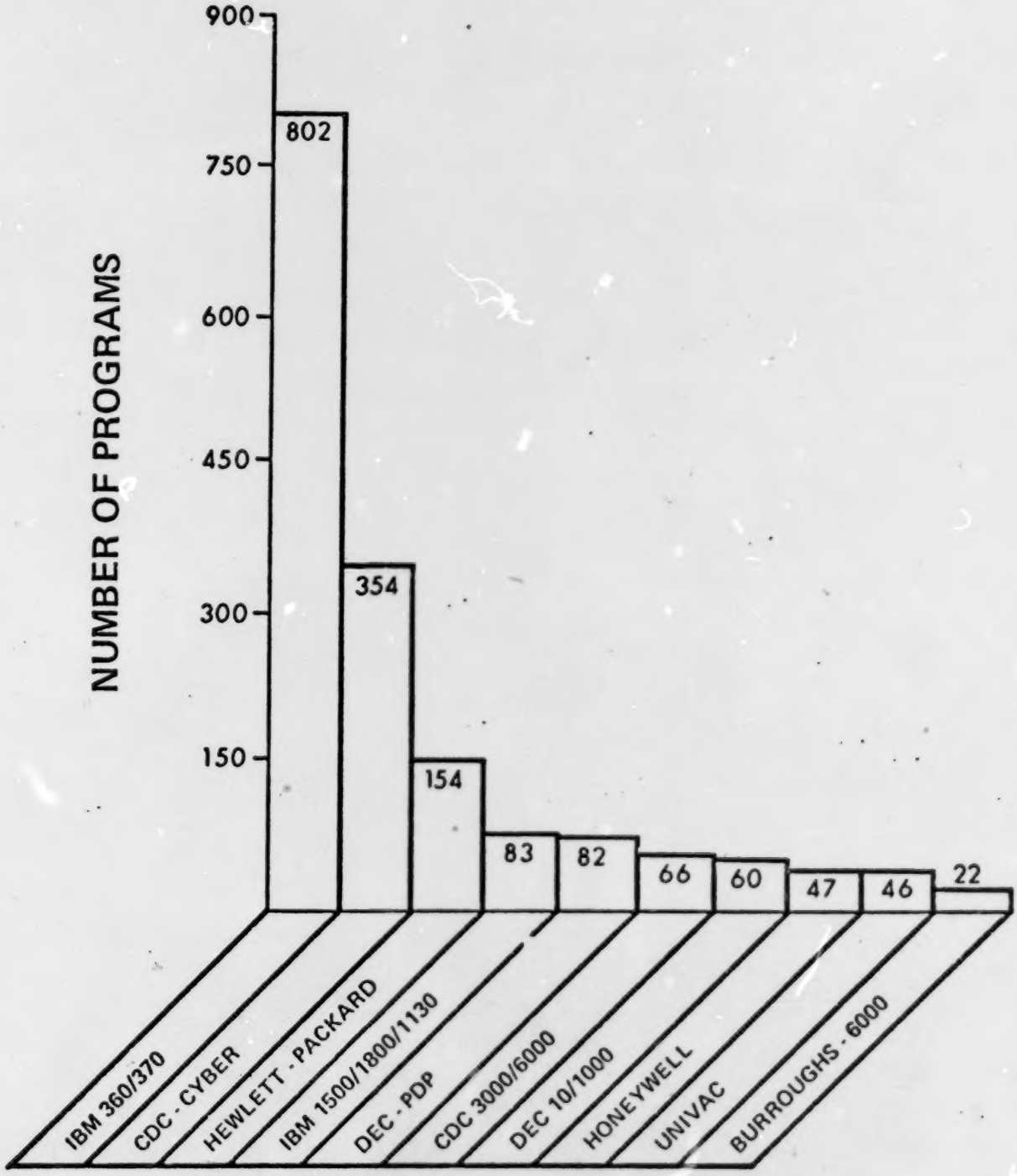
NUMBER OF PROGRAMS
900
750
600
450
300
150
802
354
154
83
82
66
60
47
46
22
IBM 360/370
CDC - CYBER
HEWLETT - PACKARD
IBM 1500/1800/1130
DEC - PDP
CDC 3000/6000
DEC 10/1000
HONEYWELL
UNIVAC
BURROUGHS - 6000

FIGURE 3A

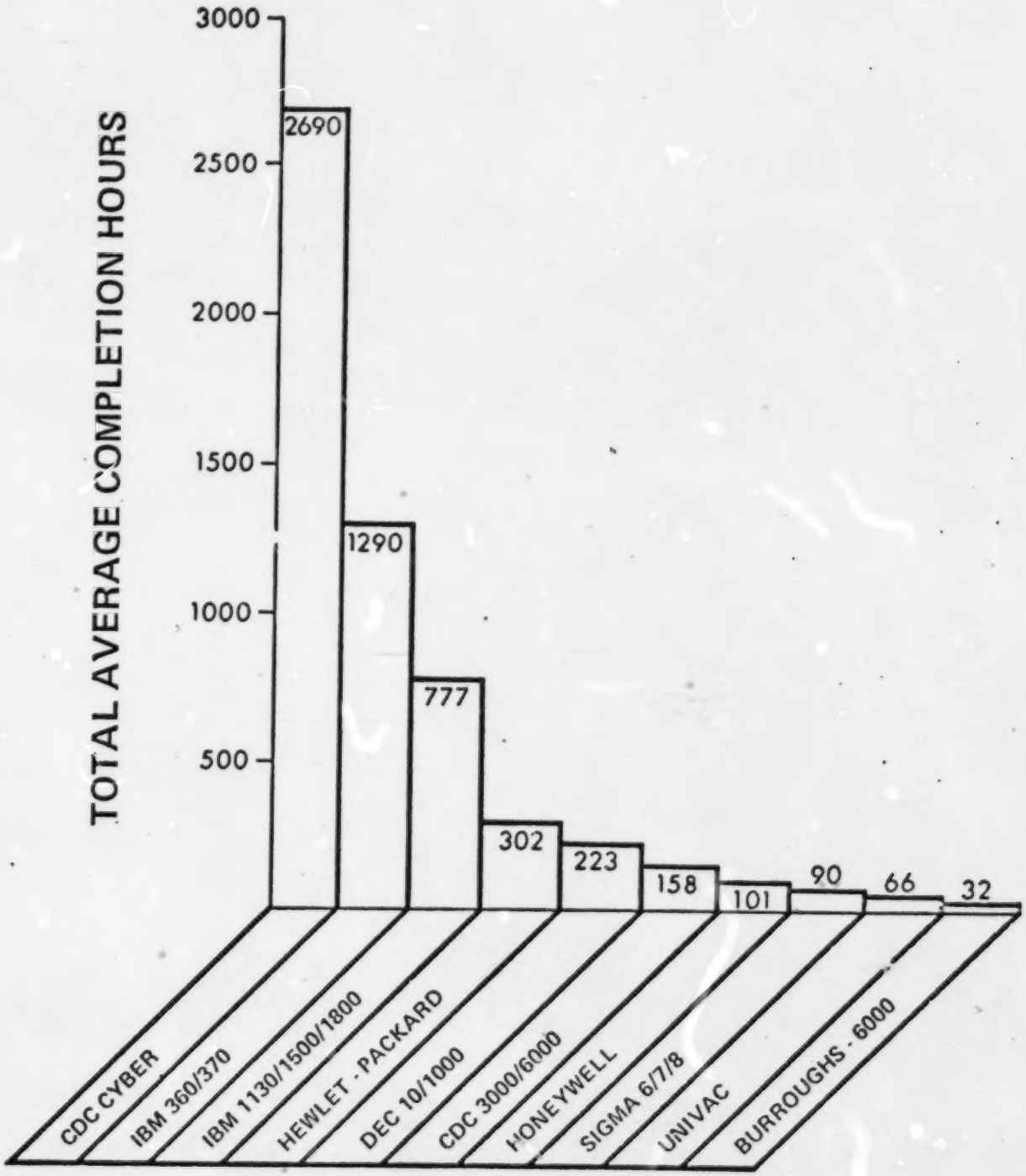
TOTAL AVERAGE COMPLETION HOURS
3000
2500
2000
1500
1000
500
2690
1290
777
302
223
158
101
90
66
32
CDC CYBER
IBM 360/370
IBM 1130/1500/1800
HEWLET - PACKARD
DEC 10/1000
CDC 3000/6000
HONEYWELL
SIGMA 6/7/8
UNIVAC
BURROUGHS - 6000

FIGURE 3B

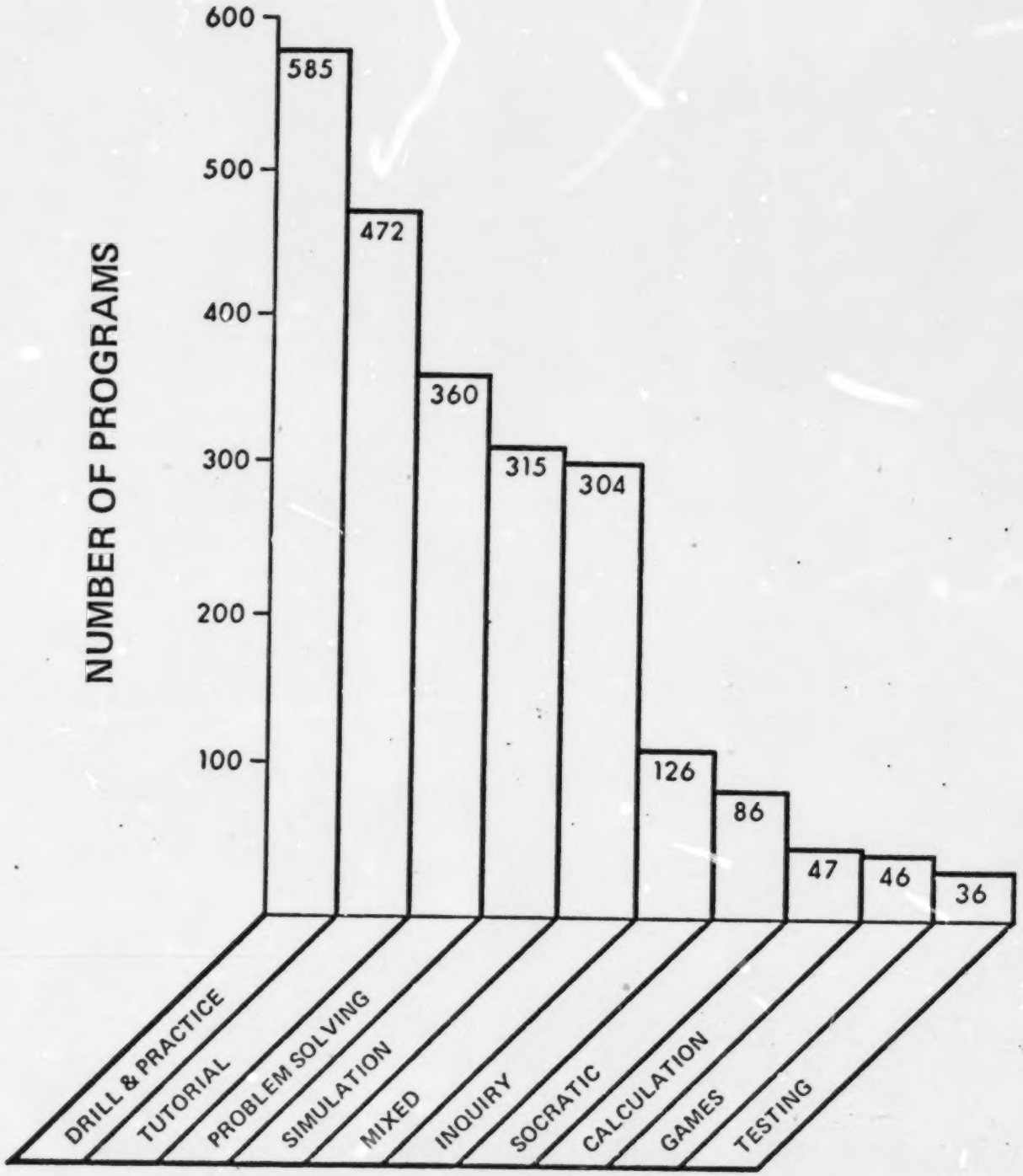
NUMBER OF PROGRAMS
600
500
400
300
200
100
585
472
360
315
304
126
86
47
46
36
DRILL & PRACTICE
TUTORIAL
PROBLEM SOLVING
SIMULATION
MIXED
INQUIRY
SOCRATIC
CALCULATION
GAMES
TESTING

FIGURE 4A

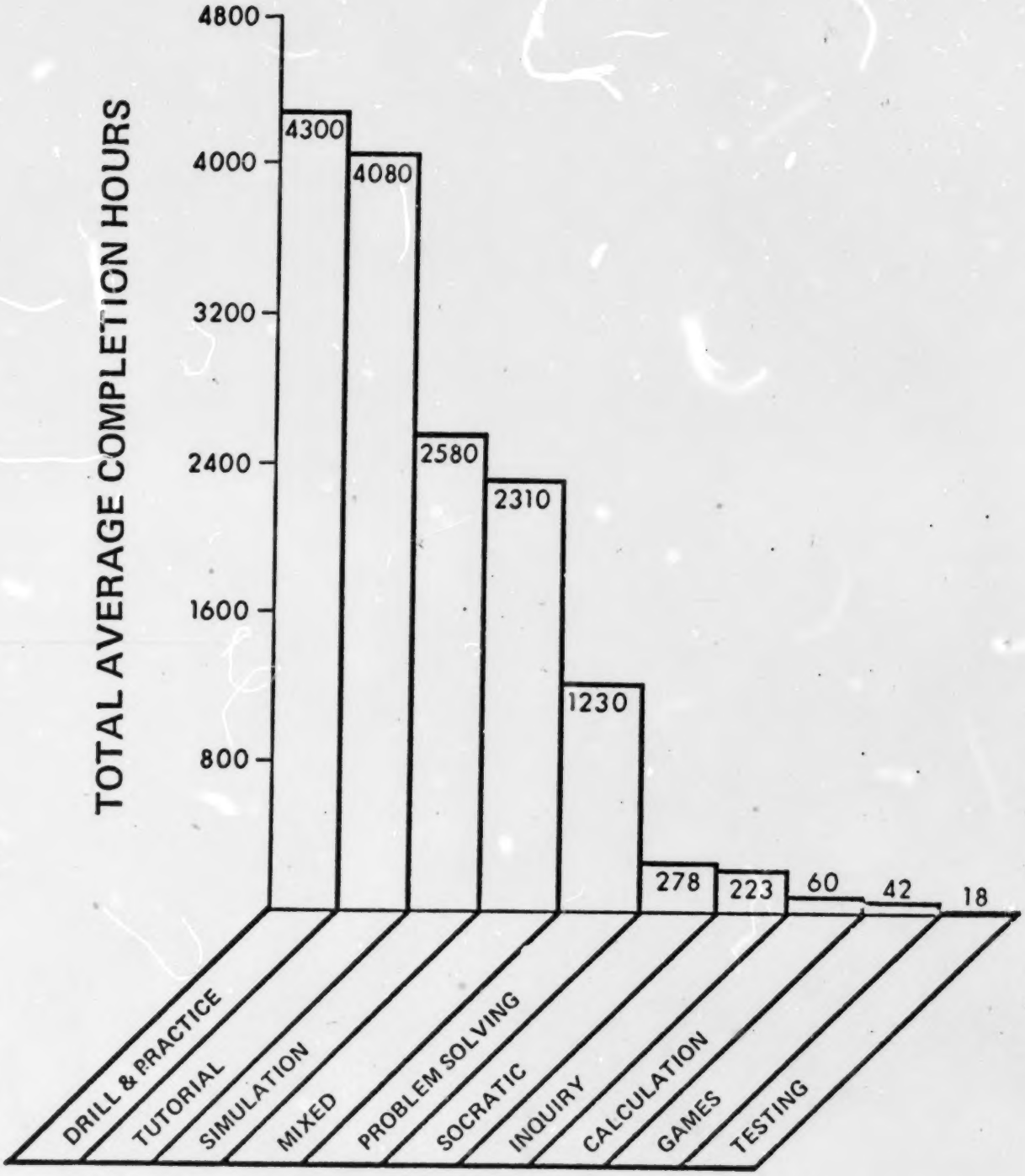
TOTAL AVERAGE COMPLETION HOURS
4800
4000
3200
2400
1600
800
4300
4080
2580
2310
1230
278
223
60
42
18
DRILL & PRACTICE
TUTORIAL
SIMULATION
MIXED
PROBLEM SOLVING
SOCRATIC
INQUIRY
CALCULATION
GAMES
TESTING

FIGURE 4B

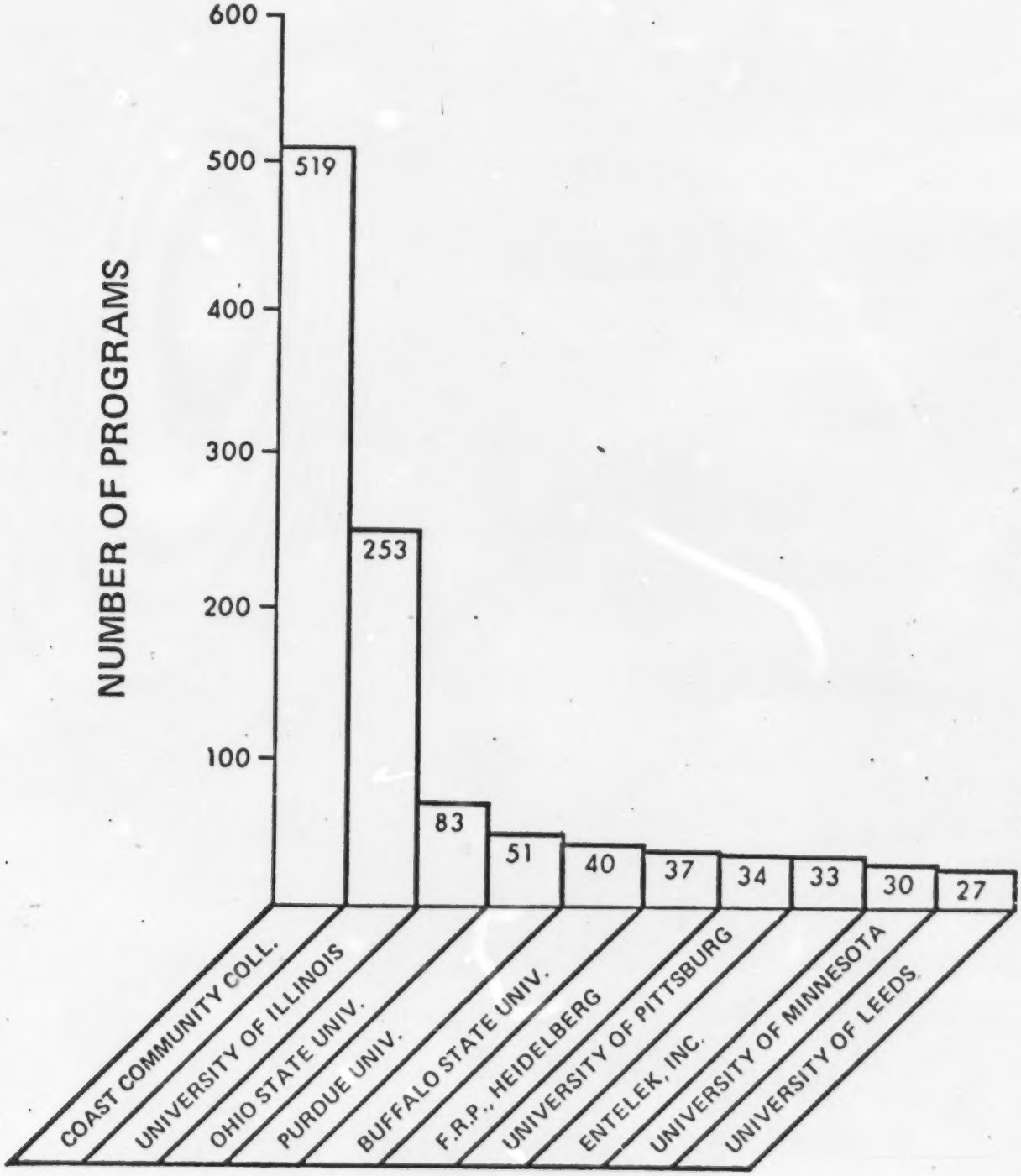
NUMBER OF PROGRAMS
600
500
400
300
200
100
519
253
83
51
40
37
34
33
30
27
COAST COMMUNITY COLL.
UNIVERSITY OF ILLINOIS
OHIO STATE UNIV.
PURDUE UNIV.
BUFFALO STATE UNIV.
F.R.P., HEIDELBERG
UNIVERSITY OF PITTSBURG
ENTELEK, INC.
UNIVERSITY OF MINNESOTA
UNIVERSITY OF LEEDS

FIGURE 5A

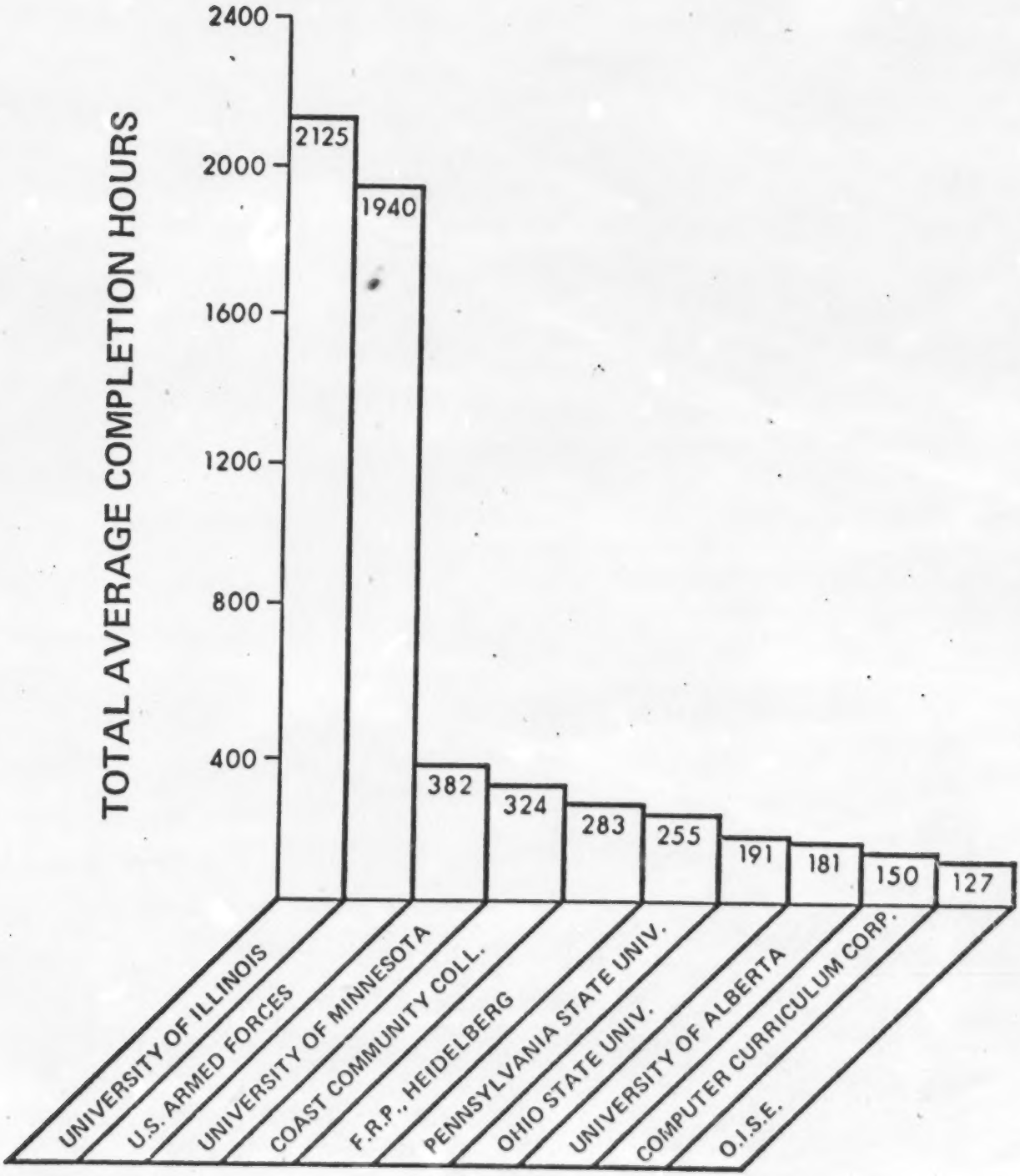
TOTAL AVERAGE COMPLETION HOURS
2400
2000
1600
1200
800
400
2125
1940
382
324
283
255
191
181
150
127
UNIVERSITY OF ILLINOIS
U.S. ARMED FORCES
UNIVERSITY OF MINNESOTA
COAST COMMUNITY COLL.
F.R.P., HEIDELBERG
PENNSYLVANIA STATE UNIV.
OHIO STATE UNIV.
UNIVERSITY OF ALBERTA
COMPUTER CURRICULUM CORP.
O.I.S.E.

FIGURE 5B